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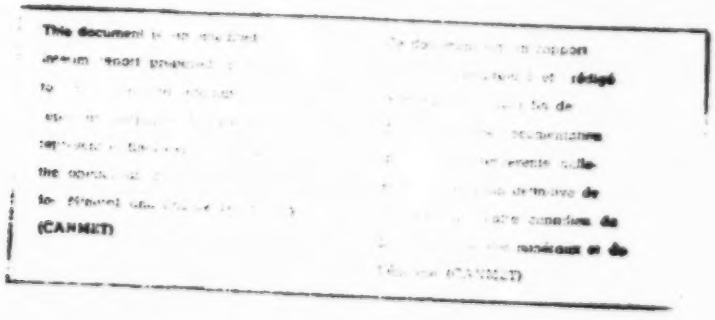
SURFACE COAL MINING IN YUGOSLAVIA

Val Srajer

December 1986



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MINERAL AND ENERGY RESEARCH PROGRAM
COAL RESEARCH LABORATORIES
DIVISION REPORT M & ERP/CRL 86-146(TR)

SURFACE COAL MINING IN YUGOSLAVIA

by

V.Srajer*

ABSTRACT

The surface coal mines in the Tuzla basin in Yugoslavia were visited on Monday, November 24, 1986. At present, total annual production from the region is 5.57 Mt, planning to be increased to 10 Mt by the year 2000. Almost 60 % of the coal production now is from underground mines. By the year 2000 this ratio will change to 80 % of production from surface mines.

An extensive construction program is underway. New surface mines have been opened using continuous mining systems supplied by East and West Germany, Czechoslovakia and Soviet Union. New thermal power stations and briquette plants are being build. Over 11 000 people are employed at the mines.

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EXPLOITATION EN SURFACE DU CHARBON EN YOUGOSLAVIE

par

V. Srajer*

RÉSUMÉ

L'auteur a visité les mines de charbon en surface du bassin de Tuzla, en Yougoslavie, le lundi 24 novembre 1986. La production annuelle totale de la région est actuellement de 5 570 tonnes, chiffre qui devrait passer à 10 000 tonnes d'ici l'an 2000. Les mines souterraines sont à l'origine de près de 60 % de la production de charbon. D'ici l'an 2000, 80 % de la production devraient provenir des mines en surface.

Un programme de construction d'envergure est en cours. De nouvelles mines en surface ont été mises en service à l'aide de systèmes d'exploitation en continu fournis par l'Allemagne de l'Ouest, l'Allemagne de l'Est, la Tchécoslovaquie et l'Union Soviétique. De nouvelles centrales thermiques et usines de briquetage sont en construction. Plus de 11 000 personnes travaillent à ces mines.

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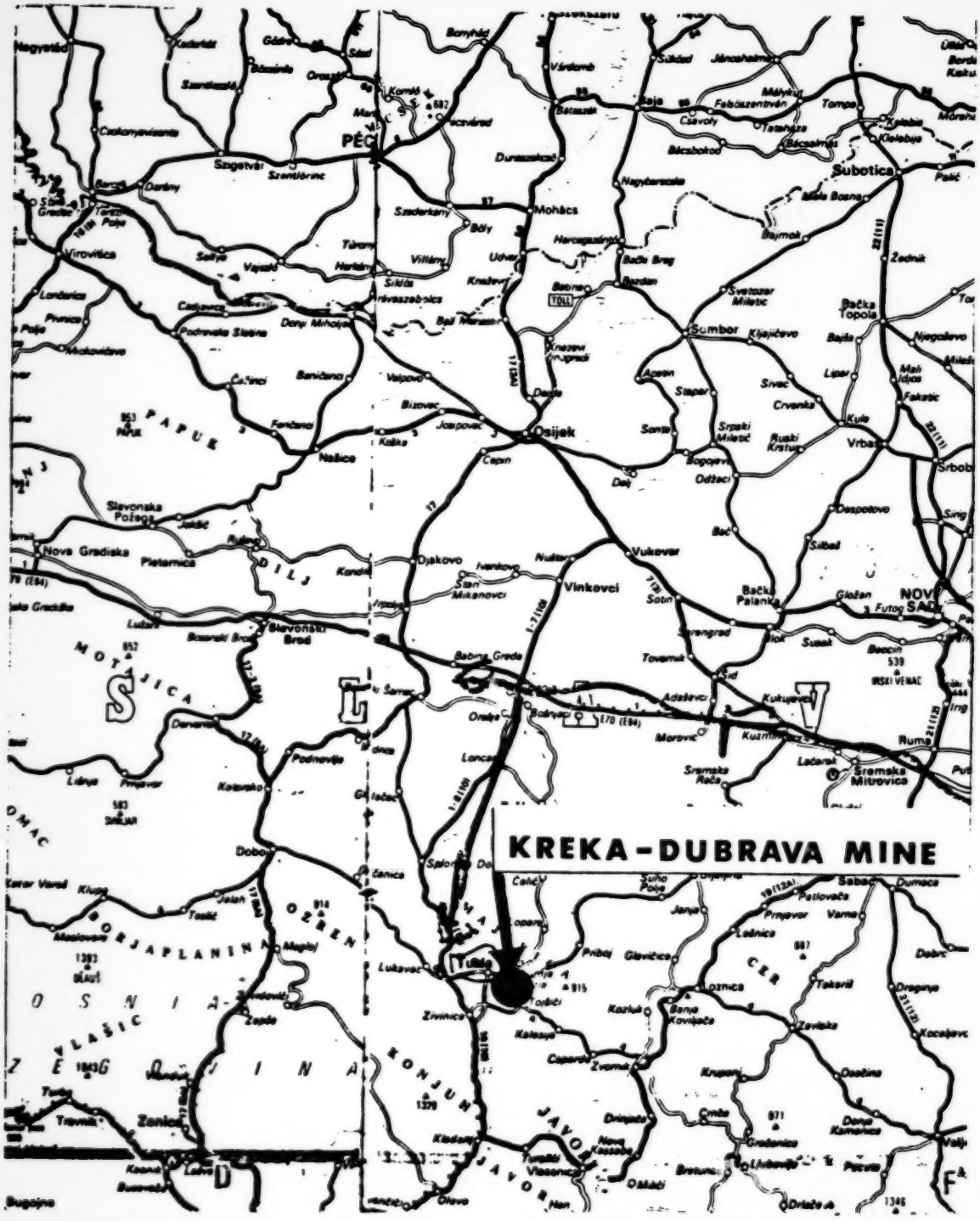
1.0. INTRODUCTION

Yugoslavia's coal resources are composed of 90 % of lignite, up to approximately 9.5 % of brown coal and 0.5 % of hard coal. Approximately 42 % of the available resources can be extracted by open cast mining methods at an overburden/coal ratio of 2.3 m^3/t and approximately 18 % at the ratio of 4 m^3/t.

The Kreka-Dubrava coal basin is located near the Town of Tuzla, in the Majevica mountain of the Yugoslavian province of Bosnia - Hercegovina. The Town of Tuzla is accessible from the Beograd - Zagreb highway, taking the paved road from Zupania turnout. The road distance from Beograd to Tuzla is approximately 230 km, a whole day trip on local highways. The location of the mine is shown on Fig.1 (1).

The visited mines are newly developed or still under construction. New equipment was installed at the mine sites, or is in various stages of erection. The proposed and approved mining method of using continuous mining systems may present serious problems for mine planners in the future, to mine isolated pockets of coal at the bottom of the projected pit, or to provide steady production when continuous mining system break down. The mine managers were quite concerned about this happening and they therefore purchased three Terex scrapers to fill this void in production planning. At present time these scrapers are assigned for the prestripping work at Dubrava mine.

In this trip report coal deposits of Kreka - Dubrava coal basin are described. The management personnel were quite prepared to answer questions about their mines, to show the machinery installed, and to provide references. They did not allow me to take photos inside mine area boundary.


KREKA-DUBRAVA MINE
Osijek
Subotica
Sombor
Vinkovci
Vukovar
Mohács
Nova Gradiska
Slavonski Brod
Bačka Palanka
NOVI SAD
Šibenik
Zenica
Tuzla
Drniš
Knin
Sinj
Split
Trogir
Omiš
Makarska
Dubrovnik
Metković
Ploče
Mostar
Konjic
Jablanica
Prozor
Gabela
Čapljina
Stolac
Trebinje
Bileća
Nevesinje
Gacko
Foča
Višegrad
Rogatica
Sarajevo
Zvornik
Bijeljina
Brčko
Derventa
Doboj
Banja Luka
Prijedor
Bihać
Cazin
Velika Kladuša
Bosanska Krupa
Sanski Most
Kozarska Dubica
Prnjavor
Gradačac
Orašje
Županja
Vinkovci
Vukovar
Ilok
Šid
Sremska Mitrovica
Ruma
Pećinci
Inđija
Stara Pazova
Zemun
Beograd
Smederevo
Požarevac
Kragujevac
Kraljevo
Novi Pazar
Priboj
Užice
Valjevo
Loznica
Šabac
Obrenovac
Mladenovac
Aranđelovac
Topola
Arilje
Ivanjica
Kosjerić
Čačak
Gornji Milanovac
Lučani
Ljig
Rudnik
Gornja Trepča
Kosovska Mitrovica
Vučitrn
Priština
Kosovo Polje
Lipljan
Obilić
Podujevo
Gnjilane
Kosovska Kamenica
Uroševac
Štimlje
Suva Reka
Prizren
Orahovac
Đakovica
Peć
Klina
Istok
Srbica
Glogovac
Kačanik
Vranje
Bujanovac
Preševo
Leskovac
Lebane
Medveđa
Niš
Aleksinac
Ražanj
Prokuplje
Kuršumlija
Blace
Doljevac
Merošina
Ćićevac
Knjaževac
Zaječar
Boljevac
Negotin
Majdanpek
Kladovo
Donji Milanovac
Golubac
Veliko Gradište
Petrovac
Smederevska Palanka
Lapovo
Batočina
Rekovac
Jagodina
Ćuprija
Paraćin
Svilajnac
Despotovac
Markovac
Ćuprija
Ćuprija
Ćuprija

2.0. COAL DEPOSITS

The lignite and coal deposits of Yugoslavia are listed in Table 1 (2).

Table 1- Deposits of Brown Coal and Lignite in Yugoslavia

Basin's Name	No. of Coal Formations	Average Thickness O/C (m)	Average O/C ratio
Kolubara	1	31-85/20-25	1.6-2.8
Kosovo	1	45-95/36-60	0.93-2.6
Kostolac	1-2	51-77/18-24	2.8-3.2
Kreka	1-4	38-136/8.5-34	3.7-5.2
Banovici	1	100/20-25	6-10
Ugljevik	1	80/20	5
Gacko	1	39/15	2.54
Kicevo	1	24/8.7	2.84
Bitolj	1	60/15.2	4
Pljevlje	1	15/25	2

In these basins several open cast mines are now in operation, in development or in planning stages. These include mines in Belacevac, Cirikovac, Polje, Siski Brod, Banovici, Tamnava, Sibovac, Drvno, Sikulje, Ugljevik, and Gacko. The geology of these deposits varies from pit to pit. The coal is divided into "brown coal" and lignite. The lignite deposits originate from the Pliocene, while the brown coal deposits are of Oligocene age.

Both lignite and brown coals are utilized in thermal power generating stations, for industrial applications or as household fuel.

The overburden in most deposits is composed of sand and sand clay. Highly cohesive material (marl) is encountered on top of the brown coal deposits. The marl is present as lumps of various shapes and sizes, and is non-uniform through the deposit.

The orientation and size of the lignite formation is very favourable from the mining point of view, while the brown coal formations are less favourable. The lignite formations have an average thickness of 8.5 to 60.0 m and the brown coal formations of 15.0 to 28.0 m. In the majority of cases extraction is accomplished on one to two levels. The depth of the deposits is in the 70 to 250 m range. The heating value of the lignite varies from 6.7 to 13.4 MJ/kg and the brown coal from 11.7 to 17.6 MJ/kg.

The lignite deposits in the Kreka basin, that were visited, have predominantly sinclinal configuration, sloping from 20^{o} to 40^{o}. The deposit is underlyed by sand formations, permeable to water. An impervious floor under pressurized ground water is also encountered.

The digging resistance of the overburden was reported to be between 200 N/cm and 900 N/cm. Spot values exceeding 1800 N/cm are encountered only in some brown coal mining operations. The digging resistance of coal formations averages 600 N/cm. At the visited Kreka basin mines several sandstone lenses were tested and the digging resistance values reached 1800 N/cm. The stability of the material at the digging and dumping sites is limited to a general embankment angle of 20^{o} in most of the mines. In the brown coal mining operations the stability of the spoil material is not ensured at angles over 40^{o}. The spoil pile height op the overburden, predominantly composed of clay, is limited to 25 m. The load-bearing capability of the floor in lignite mines is problematic, because the floor is saturated with water. In the brown coal deposits the floor bearing capacity is adequate.

3.0. MINING METHODS

Opencast mining operations of the mines planned or already operating are listed in Table 2.

Table 2: Opencast Mining Operations.

Name	Production target (Mt)	Waste/coal ratio (m^3/t)	Bench height (m)	Technology
Temnava	20	1.6	24	continuous
Sibovac	18	0.93	25	continuous
Metohija	9	2.6	20	continuous
Drmno	6	2.8	25	continuous
Suvi Dol	4	4.0	28	continuous
Gacko	2	2.0	30	continuous
Juh.Slope	6	4.0	1	continuous
Siklje	3	4.8	15	continuous
Turija	3	8.0	12	truck/loader
Ugljevik	1.7	5.0	10	truck/loader

As seen from the Table, the continuous mining system is the dominant mining method used at Yugoslavian mines. This is due to the fact that the overburden of the lignite formations consists predominantly of clay that is quite easily removed and transported by the continuous mining systems.

The mining equipment varies from mine to mine. The selection of equipment is based on geological and geotechnical conditions of the various sites and other limiting factors, not specified by management.

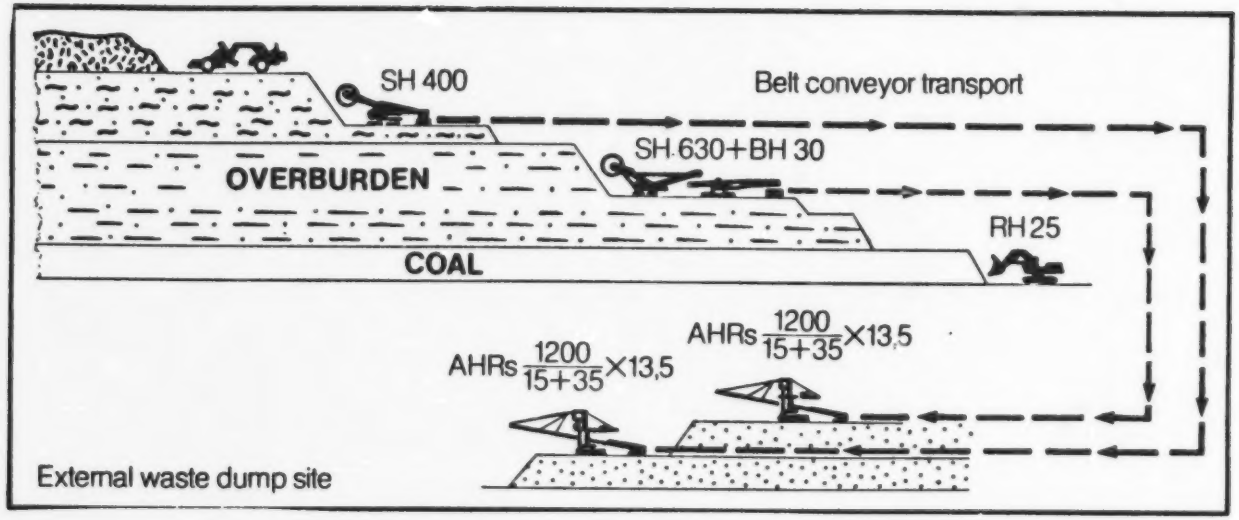


Fig. 2 - Mining Scheme

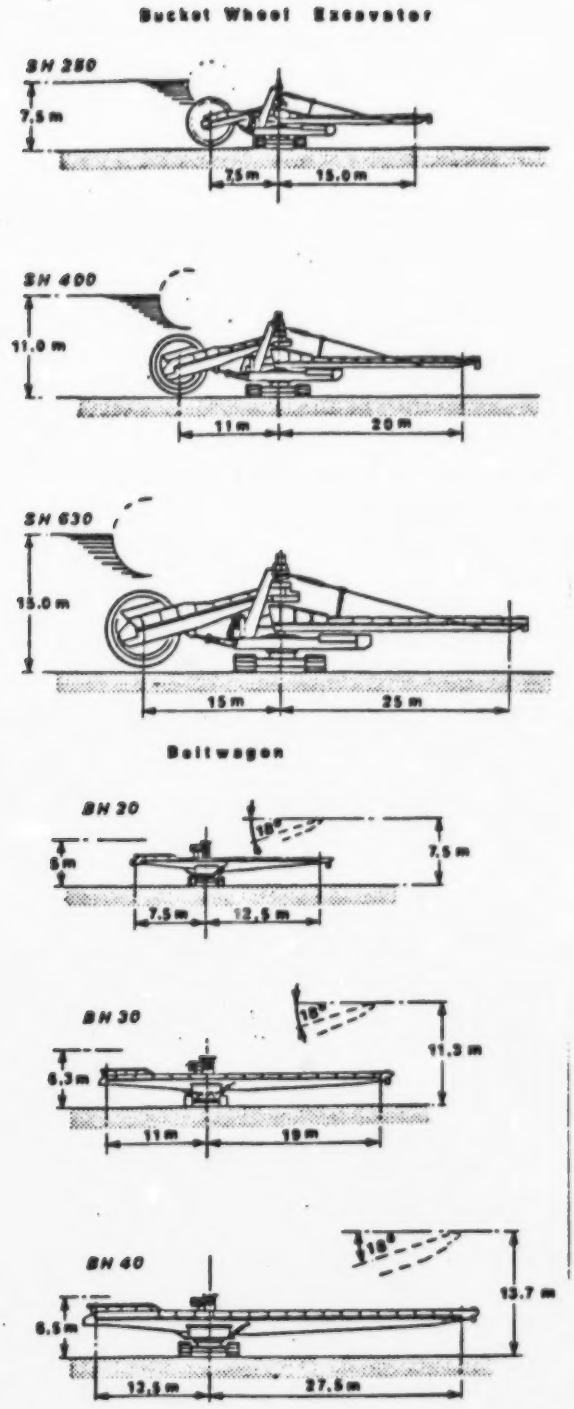
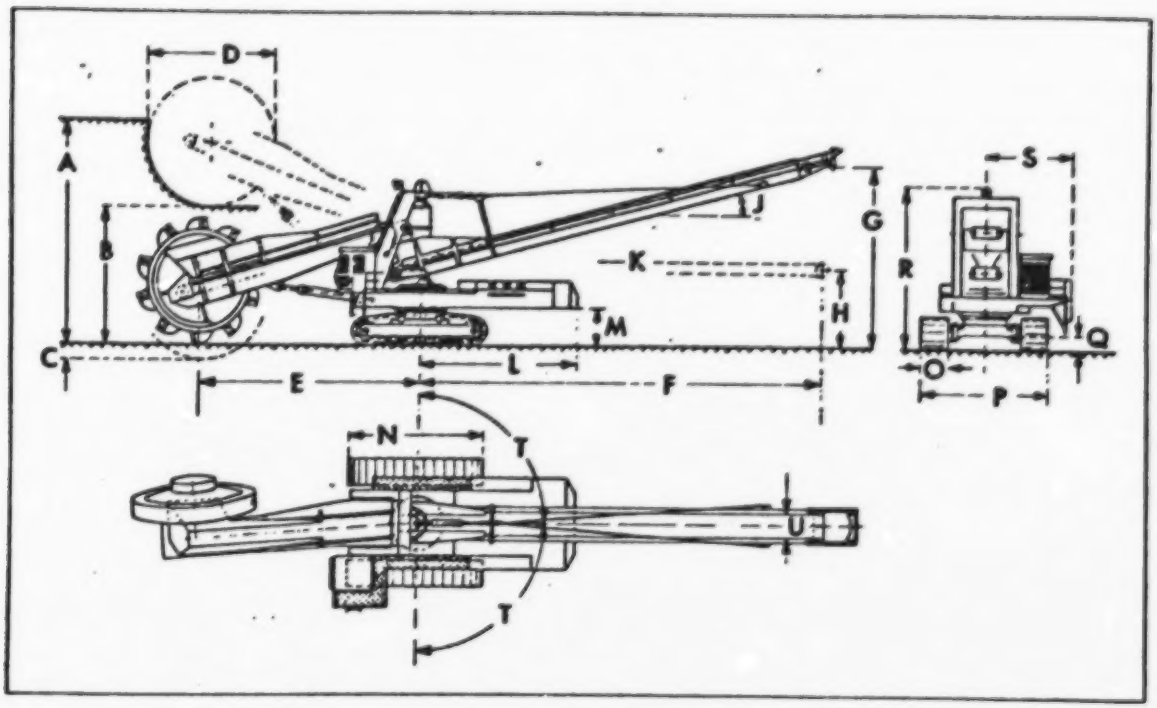
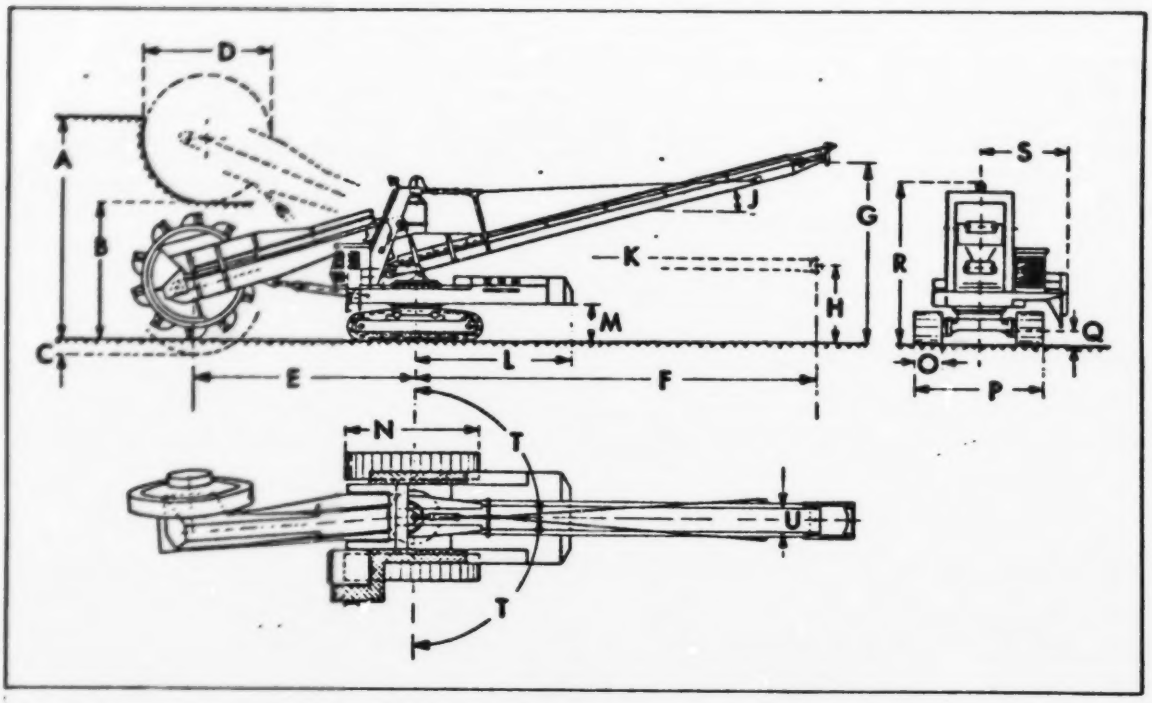


Fig. 3 - Types of BWE and Belt Wagons Used at the Mine



A	Cutting Height	11.0m	Nom. bucket capacity	400 L
B	Selective winning up to a height	6.5m	No. of buckets	10
C	Cut below ground level	0.6m	Bucket discharges/min	52-75
D	Bucket wheel dia.	6.3m	Speed of bucket wheel belt	3.6m/s
E	Outreach of bucket wheel	11.0m	Speed of discharge belt	3.6m/s
F	Outreach of discharge belt	20.0m	Slewing speed at bucket wheel	6.9– 27.6m/m
G	Max. ht. of pulley above ground	9.0m	Superstructure slewable thru	360°
H	Min. ht. of pulley above ground	3.9m	Slewability of disch. belt	180°
J	Angle of belt inclination upwards	15°	Lifting & lowering of wheel boom	3.4m/min
K	Angle of belt inclination horiz.	0°	Travel speed	0– 20m/min
L	Projection of superstructure	8.2m	Max. perm. incl. at work	1:20
M	Clearance	1.87m	Max. perm. incl. in transit	1:10
N	Length over crawlers	7.14m	Avr. sp. ground pr.	1.34kg/cm^2
O	Width of crawler tracks	1.3m	Bkt wheel drive	200kw
P	Width over crawlers	6.3m		
Q	Undercarriage clearance	0.75m		
R	Undercarriage clearance	8.1m		
S	Lateral projection of cabin	4.45m		
T	Slewing range of loading belt	2x90°		
U	Width of belts	1.2m		

Fig. 4 - Technical Data of SH-400 BWE



A	Cutting height	15.0m
B	Selective winning up to a height	9.2m
C	Cut below ground level	1.2m
D	Bucket wheel dia	8.0m
E	Outreach of bucket wheel	15.0m
F	Outreach of discharge belt	25.0m
G	Max. ht. of pulley above ground	12.8m
H	Min. ht. of pulley above ground	4.4m
J	Angle of belt inclination upwards	18°
K	Angle of belt inclination horiz.	-1°
L	Projection of superstructure	10.0m
M	Clearance	2.4m
N	Length over crawlers	9.1m
O	Width of crawler tracks	2.25m
P	Width over crawlers	9.625m
Q	Undercarriage clearance	0.7m
R	Height clearance	12.8m
S	Lateral projection of cabin	6.0m
T	Slewing range of loading belt	2x105°
U	Width of belts	1.4m

Nom. bucket capacity	630L
No. of buckets	12
Bucket discharges/min	57-82
Speed of bucket wheel belt	4.4m/s
Speed of discharge belt	4.4m/s
Slewing speed at bucket wheel	6.9-250m/min
Superstructure slewable thru	360°
Slewability of disch. belt	210°
Lifting & lowering of wheel boom	4.8m/min
Travel speed	0 - 20m/min
Max. perm. incl. at work	1:20
Max. perm. incl. in transit	1:10
Avr. sp. ground pr.	0.94kg/cm^2
Bkt wheel drive	400kw

Fig. 5 - Technical Data of SH-630 BWE

The mining system at the visited Lukavacka-Rijeka operations uses the following equipment:

Overburden removal

Scraper (Wabco 330 TF)
BWE SH-400
O&K SH-630
Mobile Hopper BH-30

Coaling operation

Hydraulic Shovel O&K RH-25
Hydraulic BWE SR-220
Belt conveyor system

Fig.2 is shows the mining scheme, Fig.3 is presents data on the excavators and belt wagons while Figs. 4 and 5 are technical descriptions of the SH-400 and SH-630 bucket wheel excavators, respectively.

Generally, the overburden removal is divided into three working levels. In the first level, irregular terrain is leveled to create conditions allowing the cost efficient employment of the continuous mining system. On the second and third level, hydraulic bucket wheel excavators SH-400 and SH-630 are used. The lower BWE is combined with a BH-30 hydraulically powered belt wagon. Two hydraulic stackers, as shown on Fig. 2, are employed at the spoil side. A smaller BWE (SH-400) at the upper level is used to remove non-cohesive material (sand), while larger BWE at the lower level (SH-630) is employed to remove predominantly clay material. This system also allows simultaneous removal on both levels.

For coaling operation a SR-220 and a RH-24 hydraulic shovel are used. The shovels operate at 5^{o} slope. The mined coal is dumped into the continuously working crusher and transported by the belt conveyor system to the coal wash plant. The hydraulic bucket wheel excavators at the mine have

warranted capacities of 450 to 900 m^3/h of clay material and 750 to 1200 m^3/h of non-cohesive overburden.

Other visited mines, Kreka-Dubrava and Sikulje, were under development. The Kreka-Dubrava mine area is planned to be 1,555 ha. Three coal seams are being excavated: Nos.2 and 3, and "Glavni". The combined thickness of the seams is from 14 to 22 m. A Czech BWE type KU-300 is planned to be used for overburden and to some extent coal removal operations. The projected capacity is around 1000 m^3 of waste material to be removed in one hour. The BWE will work on one level, 28 m high. This projected capacity is slightly lower than theoretical capacity of the machine (1200 m^3/h for similar material. The mine manager was not able to explain the reason for applying a BWE having maximum reach of 19.6 m to the 28 m high bench. It also became clear during the visit, that mine management is well avare of the problems associated with this type of BWE - possibility of superstructure collapse when wheel is rested on the ground. Especially well trained operators were assigned to the BWE. It was also understod that they are receiving double the salary of other operators (about $400/month equivalent), but are "personally responsible" for any damage to the wheel structure due to their negligence. Where responsiblity starts and finishes was not explained. The mine selected these BWE's, because of their versatility and easy movement from one spot to other, and their ability to self-level during travel. A Takraft spreader, supllied by East Germany, is planned to be erected for the spoiling operation. No data on this spreader was available at the mine site.

Other statistical information available from the mine is presented in Table 3 (3).

Table 3 - Statistical Data of Mines Under Development

Item	Kreka-Dubrava	Sikulje
Proven reserves (kt)	94,500	90,000
Total reserves (kt)	313,000	480,000
O/B-coal ratio (m^3/t)	3.25	5.30
Years of operations	30	30
Annual production (kt)	3000	3000
Start of operation	1987	1986
1st full prod. year	1990	1991
Investice (Din./t)*	10,230	10,007
Heating value (KJ/kg)	9,450	8,600
Moisture (%)	32.46	44.04
Ash content (%)	18.75	7.88
Sulphur content (%)	0.67	0.63
(* 1 Can. $ equal approx. 300 Dinars)		

Overall view of the mining operation and the mines visited is apparent from Fig.6 (3).

In addition to the information provided, the mine management supplied their view on operation planning and their reasoning behind selection of the equipment. It was explained that a certain number of opencast mines in Yugoslavia exist, where the bench height is limited to 10 - 15 m and the floor is steeply inclined. These conditions allow the cost efficient use of hydraulic shovels, continuous mining equipment is not recommended. The hydraulic shovels may also be used effectively in the coal formations where the thickness of the coal seam and overburden combined is lover than 10 m. The shovels are employed without prior blasting work, and are preferably assigned in steeply inclined deposits (synclinal morphology). They are highly mobile and have low bearing pressure.

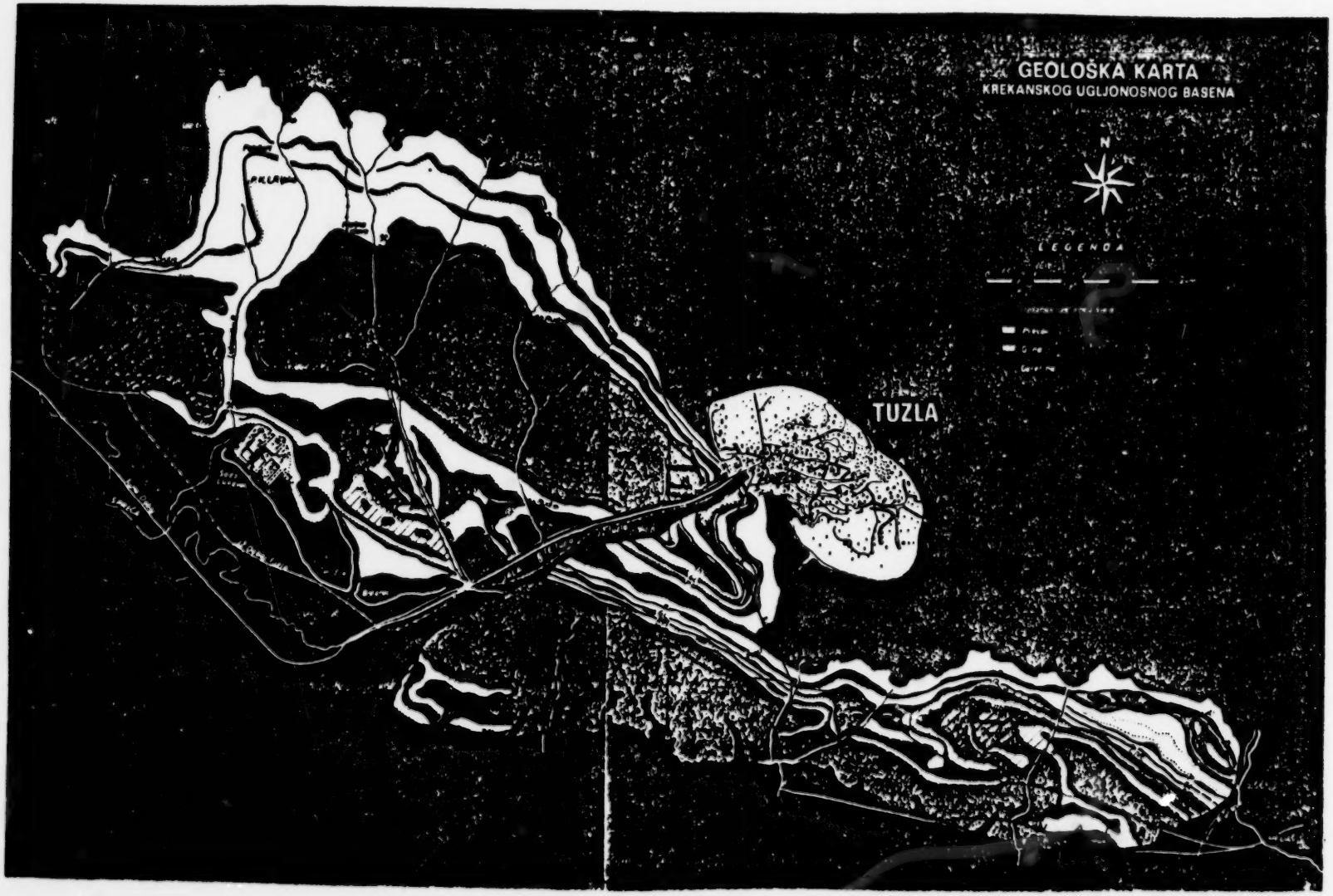


Fig. 6 - Kreka-Dubrava Mines Area

4.0. ACKNOWLEDGEMENT

The author is grateful to the management of the Kreka-Dubrava mine in Tuzla, Yugoslavia, especially to Mr. M. Jakovac, Mine Manager, Mr. Z. Zvonimir, Technical Director, and Dr. M. Simonovic, Professor of Mining and Technical Advisor, for the opportunity to visit the mining operation, their technical quidance and hospitality.

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